INSIGHTS INTO THE CHALCOLITHIC / EARLY BRONZE AGE COLONIZATION OF THE ḤARRA (NE-JORDAN) – PART I: TŪLŪL AL-GHUṢAYN

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Introduction

In the course of the Jawa hinterland project (*Arid habitats in the 5th to the early 3rd millennium B.C.: mobile subsistence, communication and key resource use in the Northern Badia [NE-Jordan]),* several surveys were carried out in the Jordanian basalt desert (*al-Ḥarra)* and the eastern adjacent limestone desert (*al-hamad)* from 2010 until 2014. These surveys revealed diverse indications for socio-economic activities in this region, especially dating to the period between the 5th and the 4th millennium calBC, which according to the Southern Levantine chronology is the Late Chalcolithic / Early Bronze Age I (LC/EBA I)[1]. A major result of these surveys was the discovery of the two hillfort sites Tūlūl al-Ghuṣayn and Khirbat Abu al-Ḥuṣayn in the basalt desert, which according to the few surface finds could provisionally be dated to the LC/EBA I (Müller-Neuhof 2013b, 2014b).

Contrary to the abundant nomadic pastoral campsites which were identified along wadis and mudpans in the basalt desert, and which hint at a seasonal occupation of the region during the winter rainy season, the two hillfort sites can be regarded as permanently occupied. This is indicated by the defence works, whose (defensive) strategic benefit could only be preserved by a permanent presence of at least part of the inhabitants or residents. The identification of these hillfort sites proves that, despite the arid conditions of today, this region was not only used on a seasonal basis but also occupied permanently. This discovery was the motive to continue the Jawa Hinterland Project with a new three-year project phase, focussing on *'The colonization of the Northern Badia (NE-Jordan) in the Late Chalcolithic and Early Bronze Age (4th to 3rd millennium BC): A contribution to archaeological settlement geography in the arid regions of Southwest Asia*', which is again funded by the *Deutsche Forschungsgemeinschaft* (DFG)[2].

Four major aims were defined during project planning, including:

- The identification of additional hillfort sites and other perennial settlements in the basalt desert
- The establishment of a chronology for the LC/EBA I settlements Tūlūl al-Ghuṣayn, Khirbat Abu al-Ḥuṣayn, and possibly other comparable sites in the Northern Badia (including Jawa), based on C^{14} data
- The characterisation of the socioeconomic conditions in the settlements, with consideration of subsistence economies such as agriculture and animal husbandry
- The identification of water management strategies (*e.g.* irrigation agriculture and water procurement) in the settlements and their immediate vicinity

Methodologically, this project focuses on surveys, small-scale excavations and soundings in a wider regional approach, in order to understand human occupation and settlement dynamics in this northeastern badia landscape during protohistory. The first fieldwork season was undertaken at Tūlūl al-Ghuṣayn in April 2015.

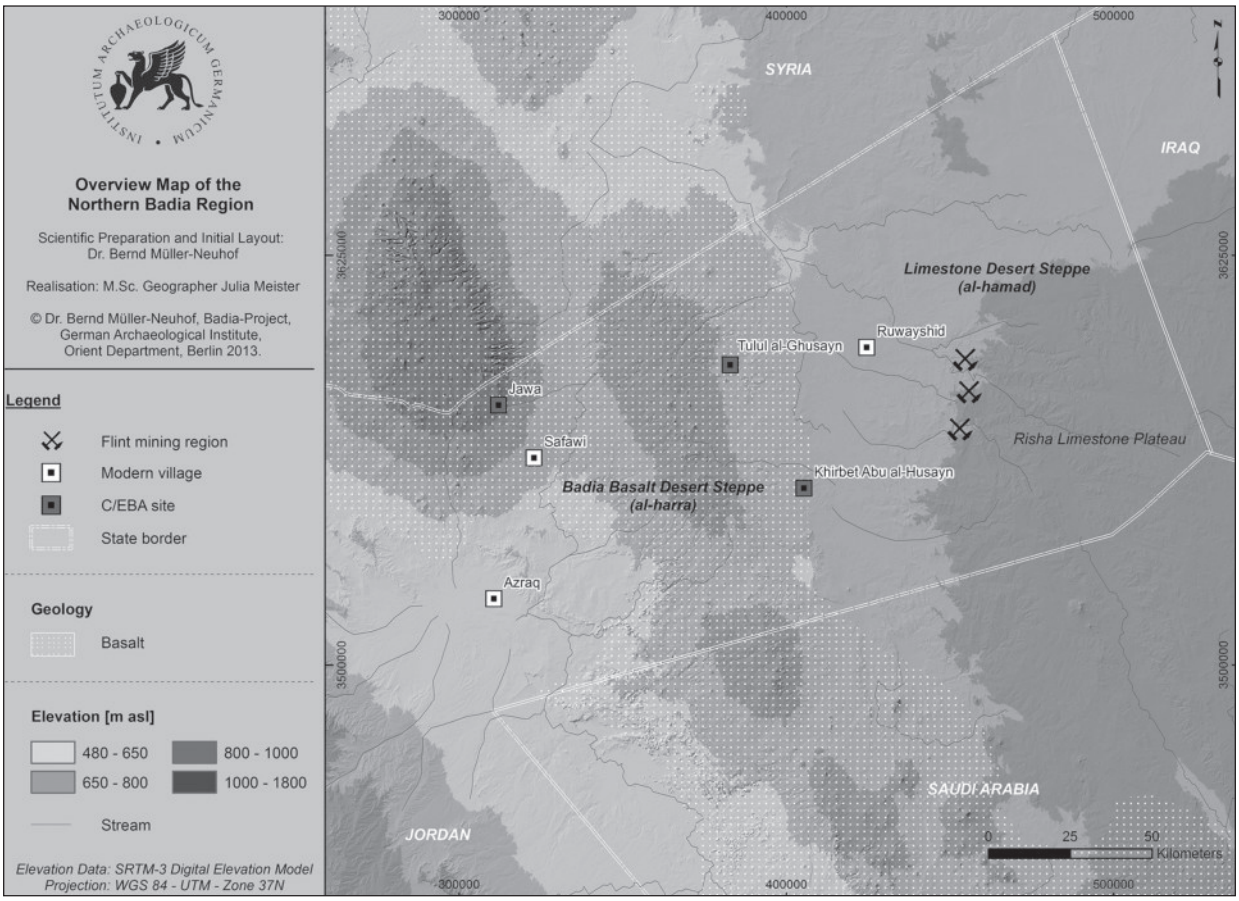
1. Concerning publications of preliminary results of these surveys refer to Müller-Neuhof 2012a, 2012b, 2012c, 2013a, 2013b. 2013c, 2013d, 2013e, 2013f, 2014a, 2014b, 2014c, 2015.

2. German Research Foundation (DFG MU-3075/3-1).

Setting

Tūlūl al-Ghuṣayn (32°27'22.69" N, 37°45' 6.38" E) (hereafter TaG) is located north of the 'Ammān – Baghdad road in the eastern half of the *ḥarra*; c. 72 km aerial distance east of Jawa and c. 25km west of the eastern edge of the *ḥarra* (**Fig. 1**).

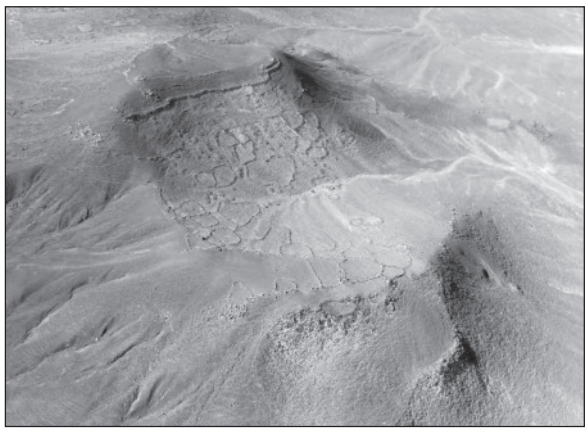
'Tūlūl', the first word of the name, refers to



1. Map of the northern Badia (©J. Meister and B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

two elevations; in this case, two neighboring volcanoes. However, the archaeological site name Tūlūl al-Ghuṣayn refers only to the western volcano, on which the ancient settlement is located. This volcano is characterized by a crater (**Fig. 2**) which is blown out on its southwestern side, a rim on the preserved edges of the crater, which is relatively wide on the southeastern part, and an elongated terrace-like elevation beginning on the foot of the southeastern outer flank of the volcano, which expands in a southeasterly direction.

The site was discovered by David Kennedy and Robert Bewley in 2011 during one of the APAAME Project aerial reconnaissance flights, who kindly provided this project with the photos and coordinates. The first phase of the Jawa hinterland project in 2013 included a preliminary inspection of the site, examining visible structures on the surface, together with a quick preliminary documentation, over two

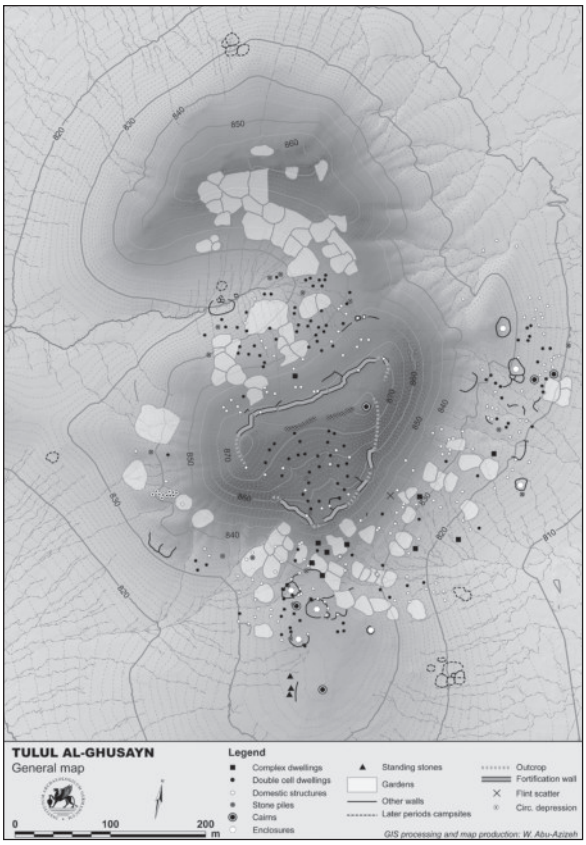


2. Aerial View of Tūlūl al-Ghuṣayn (©B. Müller-Neuhof, courtesy of APAAME).

half-days (Müller-Neuhof 2013b, 2014b).

In April 2015, two weeks were spent at TaG. One of the first tasks of this season was to identify the extension of the settlement area, the different residential / activity areas, and the characterization of the different structural remains visible on the surface. The surface survey revealed a total of 329 structures and activity areas (**Fig. 3**), comprised of four cairns, a post Ch/EB I campsite, one flint scatter site, 17 stone piles, 85 gardens enclosed by terrace walls, three groups of standing stones in rows, 126 double cell dwellings (also called 'Ghura huts' or 'double apsed' dwellings), and 10 complex dwellings. Apprximately 167 more structures were also found, mostly dwelling or storage structures, but there are also some linear structures such as terrace walls in habitation areas, and a cluster of c. 11 small circular structures, which might have been wells.

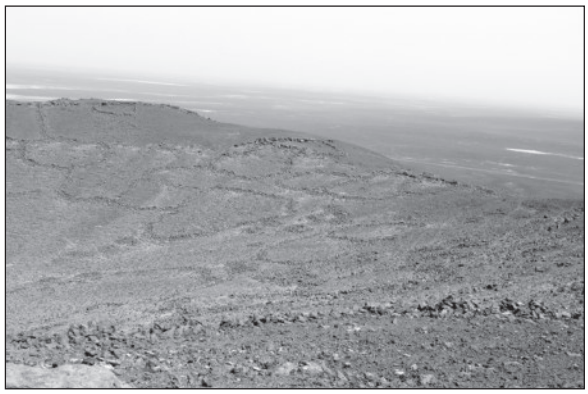
Four residential areas were identified; one inside the crater, another on top of the south ridge, one on the southern outer slope and the adjacent southern terrace, and one on the eastern outer slope of the volcano. Few buildings were observed on the south-western slope. The areas covered by terraced gardens are inside the crater and on the southern and the eastern outer slopes. Additionally, a few remains of terrace walls were identified on the southwestern slope as well. These remains may be further garden structures, but they were either destroyed by colluvial processes or were never finished.



3. General map of Tūlūl al-Ghuṣayn (©W. Abu-Azizeh, Deutsches Archäologisches Institut, Orientabteilung).

Terraced Gardens

During the survey of the terraced gardens in the crater and on the southern and eastern outer slopes of the volcano (**Fig. 4**), both the gardens and the terrace walls (which in parts were preserved up to a height of 1m; **Fig. 5**) were documented, and soil samples for future soil analyses were obtained. An interesting feature, which had already been observed in the terraced gardens at Jawa (Müller-Neuhof 2014c; Meister *et al.* 2016), are outlets or overflows which could be identified in the terraced gardens at TaG, and which clearly prove the management



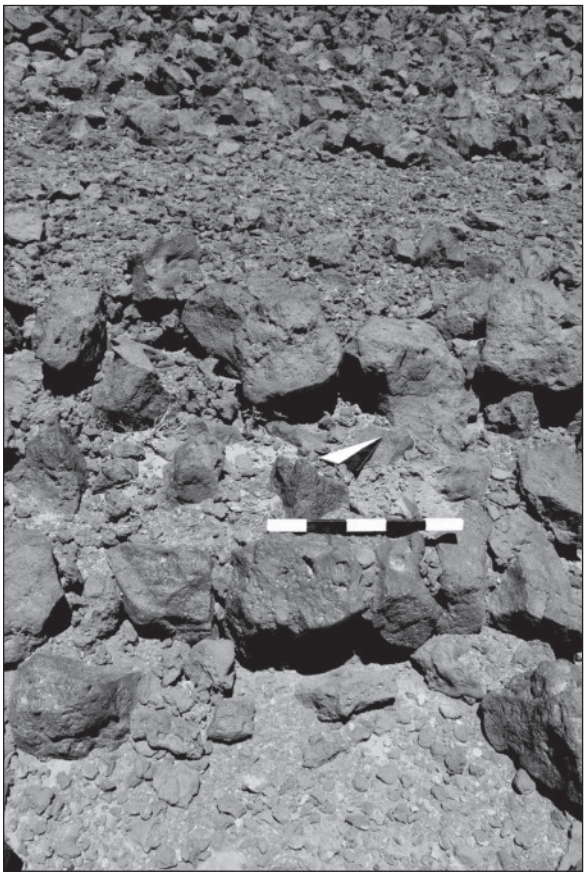
4. View into the eastern part of the crater at Tūlūl al-Ghuṣayn with garden terraces (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

5. Garden terrace wall in situ (scale 0.5 m) (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

of water irrigation (rainwater harvesting). These overflows are built in the terrace walls between the upper and lower gardens, and enabled the distribution of water from the upper garden to the lower garden according to the cascade principle. Such overflows are usually characterized by a gap in the wall, which is usually placed close to the edges of the lower terrace wall. Just below the gap, the soil surface of the lower garden is sealed with a stone pavement or one or two steps, which enables a wide and smooth dispersion of the water into the lower garden, and reduces the erosional impact on the soil surface when the water runs through the gap (**Fig. 6**).

Fortified Upper Residential Area

The residential area on the ridge consisted entirely of double-cell dwellings, which are characteristic for Tūlūl al-Ghuṣayn, and whose sizes and construction are discussed below.



6. Overflow steps between two garden terraces (scale 0.5 m) (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

Besides the double-cell dwellings, a looted cairn on the topmost point of the eastern end of this area, from which a linear row of small stone piles protrudes towards the west, is another prominent feature of this part of the entire settlement. This feature follows the characteristic layout of tailed tombs(3), known from several areas of the arid landscape in Near Eastern deserts, and which are generally tentatively attributed to a wide 4th – 3rd millennia chronological timeframe (Abu-Azizeh *et al*. 2014; Abu-Azizeh 2011 and references herein). The entire residential area on the ridge is largely fortified by a wall, constructed of c. 0.75-1.00 m wide double faced masonry erected on a basalt outcrop, and in some areas preserved to a height of almost one meter (**Fig. 7**). In some areas large basalt outcrops were included in the fortification; here, further masonry was probably not necessary, but if it was, it no longer exists. Additionally, the very steep slopes on the eastern and western end of this area were not further strengthened by walls, since they offered a natural fortification. Five to six gates or posterns gave access to this area of the settlement (**Fig. 8**), which may have served as a refuge fort for the inhabitants of the other settlement areas of Tūlūl al-Ghuṣayn. At least two clear access routes, with a partly serpentine course, could be identified on the southern side of the fortified settlement area, which enabled a controlled and easily defensible access (**Fig. 9**).

Residential Areas South and East

Besides the terraced gardens, a large number of dwelling structures (double-cell dwellings

7. Section of the fortification wall on the southern edge of the fortified upper residential area (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

3. Called "pendants" by Kennedy (e.g. 2011: 3189).

8. Gate no. 1 of the fortified upper residential area (scale 0.5 m) (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

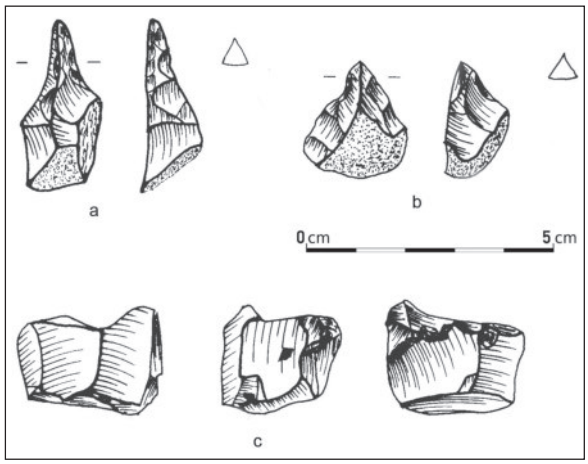
9. Access route to Gate no. 1 (scale 0.5 m) (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

and larger structures) were built on the eastern and southeastern slopes of the volcano and the southern adjacent terrace (**Fig. 10**). An interesting observation is that some dwellings were erected on very steep slopes, and terraces presumably served to secure building areas and paths. An important discovery on a steep upper part of the eastern slope was a flint scatter,

10. Garden terraces on the southern slope of the crater, below the fortification wall of the upper residential area (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

with carnelian cores, carnelian debitage, and drills which reflect a (open air?) carnelian bead workshop (**Fig. 11**). It was not attached to a dwelling and its extent could not be clearly identified, due to the cover of this area by stones which had slipped down the steep slope.

The residential area on the southern foot of the volcano extends several meters on the southerly adjacent elongated terraced elevation. Here, the residential area is mostly characterized by double-cell dwellings and some slightly larger, two-room buildings. In many cases, these buildings are incorporated into the walls of enclosures, forming clusters of residences, probably belonging to single families. Such a pattern could not be observed in the other residential areas, where buildings occasionally connect to garden terraces, but in most cases stand isolated.



11. Carnelian bead workshop implements: a and b: flint drills, c: carnelian core (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

The Southwest Residential Area

The southwestern outer slope of the volcano is characterized by a few isolated dwellings, four large isolated garden terraces with incomplete terrace walls, and some isolated terrace walls below a basalt outcrop. Of particular interest, however, is a dense cluster of 11 circular structures (**Fig. 12**) located between two gardens on a slope. Each of these circular structures measures c. 2.0 - 2.5 m in diameter, and show central depressions that are surrounded by a single row of stones. A small sounding in one of these circular structures revealed that a pit had been dug into the colluvial sediments of the slopes that were encompassed by a set of stones, in order to prevent these holes from filling up with colluvial sediments, at least during the time of their utilization (**Fig. 13**). Although a single Roman sherd was discovered in their vicinity, the time of the construction and utilization of these structures probably dates to the Late Chalcolithic / EBA I period of occupation of Tūlūl al-Ghuṣayn. The function of these structures is still unclear, but possible interpretations are silos or wells.

12. Circular structures on the southwestern outer slope of the volcano with central depressions (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

13. Section in one of the circular depressions, showing the colluvial deposit in an excavated pit (scale 0.5 m) (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

Standing Stone Structures

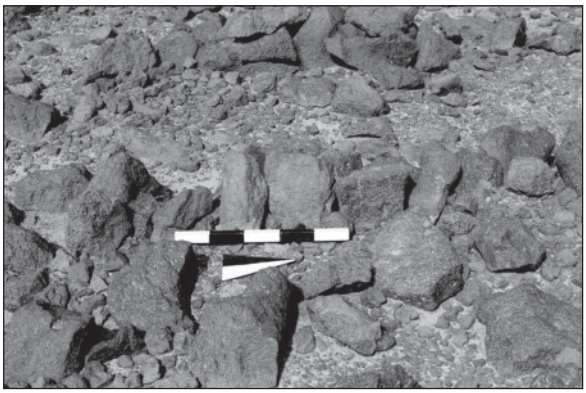
While the northern part of the elongated terraced elevation is covered with dwellings and enclosures, its southern part is characterized by a large flat empty area. Three standing stone structures (1-3) are located on the southwestern edge of this empty area. Their layout is characterized by the position of the highest upright standing stone slabs in the centre (**Figs. 14- 16**). While Standing Stone Structures 2 and 3 are characterized by single rows of stones, Standing Stone Structure 1 is characterized by at least three parallel and consecutively set rows of stones (**Fig. 17**).

All standing stone structures are clearly oriented towards the west (the sunset; **Figs. 14 - 16**), while the view to the east (the sunrise) is blocked by a nearby hill. Standing stone structures are known from southern Jordan (Abu-Azizeh *et al*. 2014: 178-179 and Fig.17, as well as references cited herein) and the Sinai (Avner 1984, 2002; also Müller-Neuhof 2014b), as well as the Arabian Peninsula (Zarins 1979 concerning the site of Rajajil for instance). Specific features of two standing stone structures (1 and 2) are stone platforms located in front of the central stones. Standing Stone Structure 1, which is the longest one, has a semi-circular platform on its western side behind the largest central stones, and a small rectangular stone platform on the eastern face in front of the central stones. Standing Stone Structure 2 is characterized by a semi-circular platform on the western side in front of the central stones. Since similar structures in the Sinai contained offerings such as cortical scrapers and grinding stones, which were placed below such platforms in connection with these standing stones (Avner 1984, 2002), test trenches were dug into the platforms of the two TaG standing stones structures; however, they did not reveal any offerings.

It is clear that the layout of these structures cannot be attributed to domestic or economic utilization (e.g. garden terraces or animal pens).

14. Standing Stones Structure 1 on the southwestern edge of the settlement (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

15. Detail of the central stones of Standing Stones Structure 2 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).



16. Detail of the central stones of Standing Stones Structure 3 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

17. Side view of Standings Stones Structure 1; note the consecutively set rows of stones. Detail of the central stones of Standing Stones Structure 2 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

The orientation of the structures towards the west allows a hypothetical interpretation of these installations as most probably relating to a cultic calendrical function, possibly connected with agricultural activities.

Dwellings

A number of dwellings are located within the settlement area on the southern foot of the volcano and the adjacent terrace. Some of them are the typical small double-cell structures which have been observed in all dwelling areas of Tūlūl al-Ghuṣayn, and which resemble the 'Ghura-huts' recently discovered on Maitland's Mesa (Rowan *et al*. 2015). These structures consist of a small main room and a small anteroom or 'forecourt'. Their length is mostly between 3.00 and 4.50 m and their width

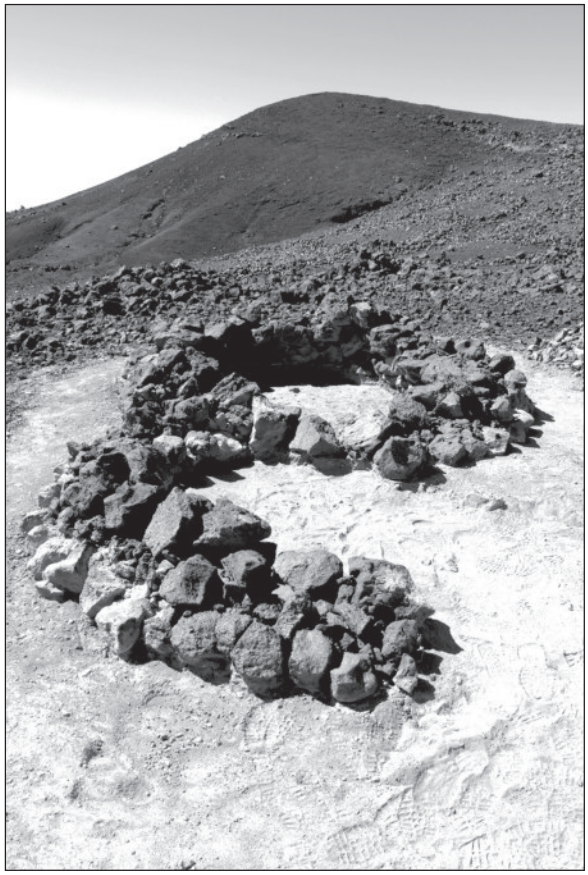
between 1.00 and 1.40 m. Typically, they have carefully constructed double-faced masonry walls of large basalt stones, filled with smaller stones between the two faces (**Fig. 18**). These walls are sometimes preserved to a height of 0.5 m or more. Interestingly, all structures in the settlement areas at Tūlūl al-Ghuṣayn have more or less the same orientation (SW-NE), with the entrance orientated towards the southeast. Additionally, some larger, more or less sub-rectangular single room dwellings were identified in this area, with lengths between 3.50 m and 4.50 m and width around 2.00 m.

During the 2015 season, two dwellings were entirely excavated; one double-cell structure (TAG 209; **Fig. 19**) and one of the larger dwellings (TAG 181; **Fig. 20**).

TAG 181 was mostly filled with aeolian sediments and stones from the walls; a complete jar was discovered *in situ* not very far beneath the surface, filled with sediments, two worked limestones and a sea shell (**Figs. 21, 22**). However, the jar was held together by the surrounding fill, and was already fragmented. Thanks to the ACOR Conservation Cooperative, the recovered sherds have been restored by Naif Zaban. An interesting observation is that, contrary to earlier statements (Müller-Neuhof 2015: 76), the jar does not show any affinities to EBA pottery in the southern Levant[4]. Its shape, but especially the very fine ware, leads us to assume that its origin might be further north, probably in the Euphrates region. (**Figs. 23 a: b**). Besides this jar, a number of lithic debitage and tools were found, notably including a cortical scraper (**Fig. 24 a**).

It is notable that no floor could be detected, which was also observed both in the second fully excavated structure (TAG 209), and in two other structures where soundings have

18. Detail of the double faced masonry for the walls of a double cell dwelling (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).



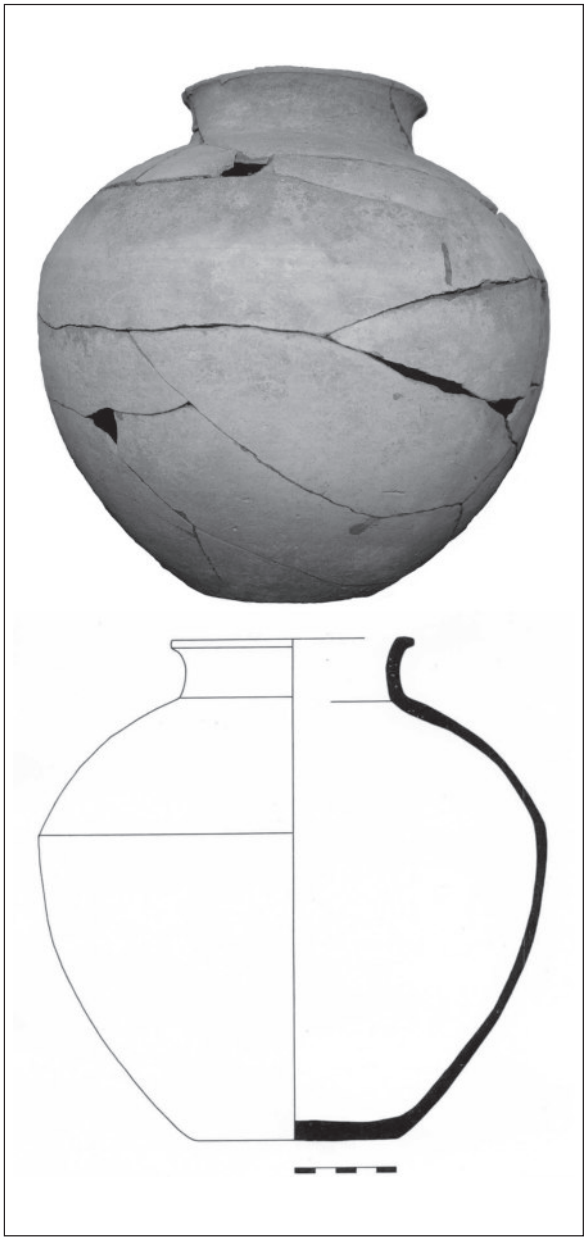
19. View of the excavated double cell dwelling structure TAG 209 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

4. We are grateful to Stephen Bourke and Susanne Richards for suggesting such a region of origin, after they saw the restored jar.

20. View of the excavated dwelling structure TAG 181 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

21. View of an almost complete jar in situ in TAG 181 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

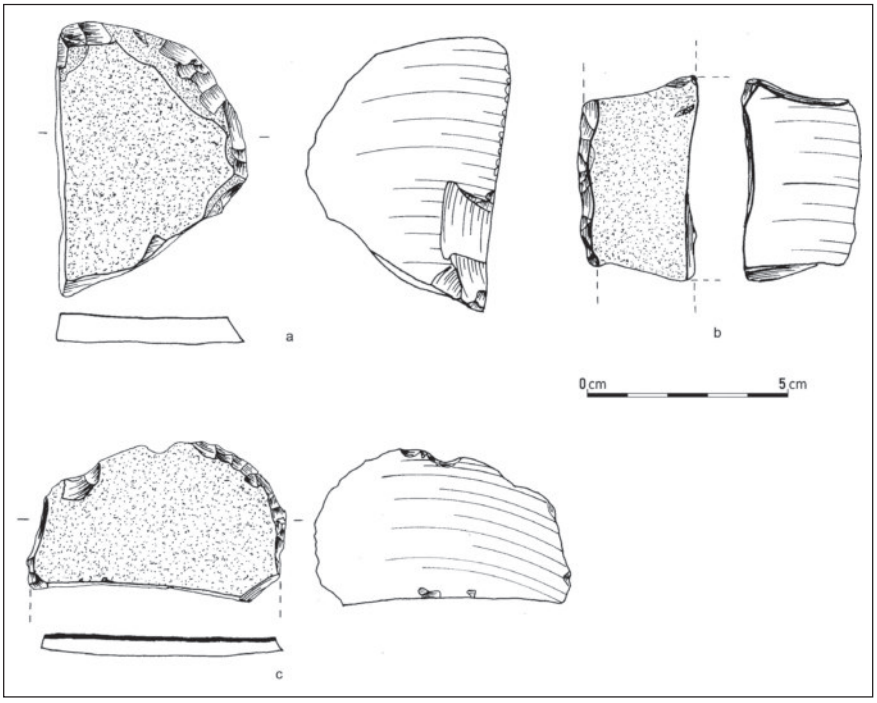
22. Contents of the jar in TAG 181; two worked limestones and a clamshell (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).



23a. Photo of the jar (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

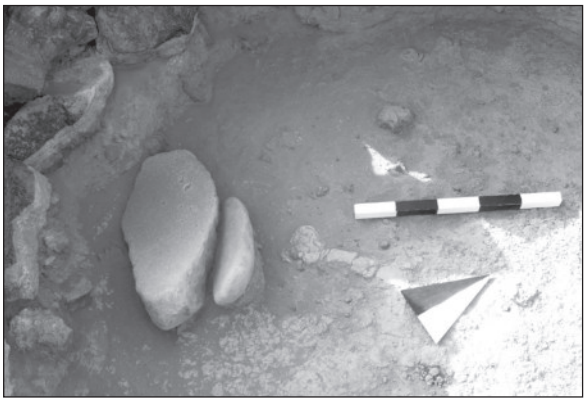
23b. Drawing of the jar (©Munjad Qassem, Deutsches Archäologisches Institut, Orientabteilung).

been carried out in order to check if floors could be identified. However an ashy area, which indicates a fire place in structure TAG 181, suggests the possible level of the floor, also indicated by the base level of the pottery found *in situ*, which was most probably lying on an occupation surface of which very few elements and artefacts were preserved. This hearth provided charcoal remains for C^{14} dating, discussed below.



24. Cortical scraper fragments from TaG: a TAG 181, b and c: surface finds (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

As already mentioned, no clearly materialized floor was detected during the excavation of the double-cell structure TAG 209, which also was filled with aeolian sediments and collapsed stones originating from the upper parts of the building walls. At c. 20-30 cm depth, two large *in situ* grinding slabs came to light (**Fig. 25**). A fireplace was identified in the forecourt (anteroom), which contained ashy sand and charcoal that was used for C^{14} dating. Once again, although no proper floor (plaster or other kind of beaten earth preparation) was identified, the original occupation surface was evidenced by a couple of grinding stones found in the cell unit and the hearth in the forecourt.



25. View of two grinding slabs in situ at TAG 209 (©B. Müller-Neuhof, Deutsches Archäologisches Institut, Orientabteilung).

Dating and Discussion

The material remains recovered in TaG were not abundant. The assemblage of surface finds and the few finds from the excavations, where all the sediments were sieved, consist mostly of a few ceramic fragments, mostly body sherds of typical hard fired, reddish coarse ware with mineral and basalt temper. Some lithic artefacts, mostly debitage with typical C/EBA primary production characteristics (*e.g.* broad platforms, cortical platforms) were also found; among the lithic tools some drills and cortical scraper fragments are worth mentioning. Comparably abundant were grinding stones (mostly fragments, but some complete), most of which were hand stones, clearly indicating the processing of agricultural products on the site, and supporting the hypothesis that the terraced gardens were used for agricultural purposes. This was also supported by the discovery of two large grinding slabs in dwelling TAG 209. Grinding stones are indeed relatively poorly represented in the material culture of the arid margins occupation, and their unusual abundance at TaG (more than 20 scattered on the surface of the site and its dwelling units) stands in strong contrast with the pastoral nomadic occupation picture. All in all, the material remains indicate at least a LC/EBA date for the occupation in TaG.

The charcoal remains from the fireplaces in the excavated dwellings TAG 181 and 209 reduce the range of dating to the period between 3,700 and 3,400 calBC (Müller-Neuhof and Abu Azizeh 2016; **Fig. 26**). The occupation of TaG therefore has to be chronologically placed into EBA IA and/or the beginning of EBA IB. Such a dating fits nicely with early occupation layers at Jawa, as indicated by the recently published radiocarbon dates from this site (Müller-Neuhof, Betts and Wilcox 2015).

Of particular importance is the fortified character of TaG, which suggests a permanent occupation of the settlement, at least for some of the population. It appears that if Khirbat Abū al-Ḥuṣayn (KAH) dates to the same period (Müller-Neuhof 2013b), there is a pattern of fortified EBA settlements in the *Ḥarra*, which consists now of Jawa, TaG, KAH and the newly discovered site Khirbat Ja'bariya (KaJ), where the first field season was undertaken in 2016 (the second contribution in this *ADAJ* volume). However, it is still unclear how to determine the reasons and motivation for these fortifications.

Also important are the terraced gardens, which point to agricultural activities using rainwater harvesting irrigation, a strategy previously unanticipated this far to the east, and which show strong affinities to the contemporaneous gardens in Jawa. However, while the rainwater harvesting system in Jawa has a catchment area of c. 5 km^2, the catchment area of the rainwater harvesting system in TaG is much smaller, and encompasses only the top of the volcano and its rim. How agriculture could have been carried out under such conditions is therefore an important issue of continued research.

Finally, the standing stones are an important discovery in TaG, for they reflect affinities to similar structures in southeast Jordan, Saudi Arabia, the Sinai, and the Negev. These affinities may point to extensive long-distance connections between different groups occupying the steppe and deserts neighbouring the Fertile Crescent, which may also have formed a largely independent cultural entity. However, these are hypothetical surmises that need further research, which will hopefully be derived from future material analyses, excavations and surveys, within the framework of the second part of the Jawa Hinterland Project in the coming years.

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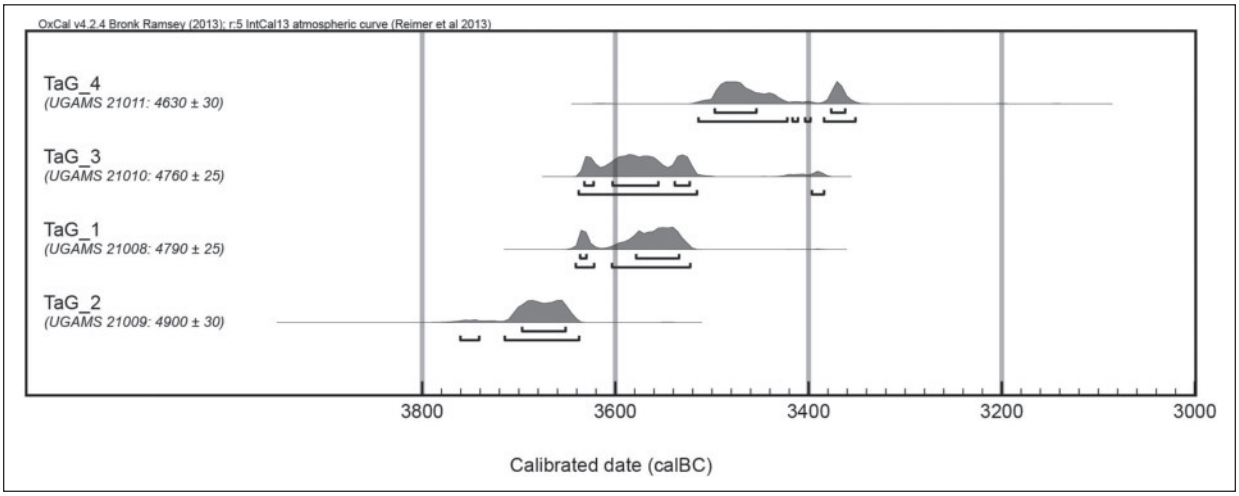

26. Chart with calibrated C^{14} dates from Tūlūl al-Ghuṣayn .

generous funding from the German Research Foundation (DFG MU 3075/1–2, MU 3075/3-1), this project would not have been possible. Finally, it has to be stressed that such a project could not have been undertaken without the cooperation and help of other colleagues. In this regard, we would especially like to thank Mr. Tobias Schmidt M.A., as well as our DoA representative Khaled al-Janaida, for their efforts and their ability to cope with the dust and three days of storm at the site and in the camp. We are additionally very grateful to Gary O. Rollefson, who took the burden of proof reading. Any remaining mistakes are ours.

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Bibliography

Abu-Azizeh, W., Tarawneh, M., AbuDanah, F., Twaissi, S. and Al-Salameen, A.
2014 Variability within Consistency: Cairns and Funerary Practives of the Late Neolithic/Early Chalcolithic in Al-Thulaythuwat Area, Southern Jordan. *Levant* 46.2: 161-185.

Abu-Azizeh, W.
2011 Structures Cultuelles et Funéraires des IV-IIIème millénaires dans le sud jordanien désertique: l'occupation de la région de Al-Thulaythuwat. Pp.21-39 in T. Steimer-Herbet (ed.), Pierres levées, stèles anthropomorphes et dolmens,. Maison de l'Orient Méditerranéen - *BAR Int. Series 2317*. Oxford: BAR.

Avner, U.
1984 Ancient Cult Sites in the Negev and Sinai. *Tel Aviv* 11: 115–131.
2002 *Studies in the material and spiritual culture of the Negev and Sinai populations, during the 6th-3rd millennia B.C*. Ph D. Hebrew University Jerusalem.

Kennedy, D.
2011 The Works of the Old Men in Arabia: remote sensing in interior Arabia. *Journal of Archaeological Science* 38: 3185-3203.

Meister, J., Krause, J., Müller-Neuhof, B., Portillo, M., Reimann, T., Schütt, B.
2016 Desert Agricultural Systems at EBA Jawa (Jordan): Integrating archaeological and palaeoenvironmental records. *Quarternary International*. http://dx.doi.org/10.1016/j.quaint.2015.12.086. [Accessed 12 September 2016].

Müller-Neuhof, B.
2012a Northern Badia. in D.R. Keller, B.A. Porter and C.A. Tuttle, Archaeology in Jordan, 2010 and 2011 Seasons. *American Journal of Archaeology* 116: 700-702.
2012b The Gardens of Jawa: Early evidence for Rainwater Harvesting Irrigation. *Bulletin of the Council of British Research in the Levant* 7: 62-64.
2012c The Wādī ar-Ruwayshid Mining Complex: Chalcolithic / Early Bronze Age Cortical Tool Production in N/E Jordan. *ADAJ* 56: 351-362.
2013a Flint Mining and Blank Production in the Chalcolithic / Early Bronze Age Period: The Greater Wadi al-Ruwayshid Region. *Bulletin of the Council of British Research in the Levant* 8: 66-68.
2013b East of Jawa: Chalcolithic / Early Bronze Age settling activities in the al-Harra (NE-Jordan). *ADAJ* 57: 125-139.
2013c SW-Asian Late Chalcolithic / EB Demand for 'Big Tools': Specialised flint xploitation beyond the fringes of settled regions. *Lithic Technology* 38.3: 220-236.
2013d Chalcolithic / Early Bronze Age Flint Mines in the Northern Badia. *Syria* 90: 177-188.
2013e Nomadische Ressourcennutzungen in den ariden Regionen Jordaniens und der Südlichen Levante im 5. bis frühen 3. Jahrtausend v. Chr. *Zeitschrift für Orientarchäologie* 6: 64-80.
2013f Preliminary Results of the 2010 Cortex Scraper Mine Survey in the Greater Wadi Ruwayshid region (N/E Jordan). Pp 71-80 in F. al-Hmoud, (ed.), *Studies in the History and Archaeology of Jordan* 11. Amman: Department of Antiquities.
2014a Northern Badia. in Corbett, G. Keller, D.R. Porter, B.A. and Tuttle, C.A. Archaeology in Jordan, 2012 and 2013 Seasons. *American Journal of Archaeology* 118: 627-628.
2014b A 'Marginal Region' With Many Options: The diversity of Chalcolithic / Early Bronze Age socioeconomic activities in the Hnterland of Jawa. *Levant* 46.2: 230-248.
2014c Desert Irrigation Agriculture: Evidences for Early Bronze Age Rainwater-harvesting Irrigation Agriculture at Jawa (NE-Jordan). Pp 187-197. In D. Morandi, Bonacossi (ed.), *Settlement Dynamics and Human Landscape Interaction in the Steppes and Deserts of Syria*. Studia Chaburensia 4. Wiesbaden: Harrassowitz.
2015 Evidence for an Early Bronze Age (EBA) Colonization of the Jawa Hinterland: Preliminary Results of the 2015 Fieldwork Season in Tulul al-Ghusayn, *Bulletin of the Council of British Research in the Levant* 10: 74-77.

Müller-Neuhof, B., A. Betts and G. Wilcox
2015 Jawa, Eastern Jordan: The first 14C Dates from the Early Occupation Phase. *Zeitschrift für Orientarchäologie* 8: 124-131.
Müller-Neuhof, B. and W. Abu-Azizeh
2016 Milestones for a Tentative Chronological Framework for The Late Prehistoric Colonization of the Basalt Desert (North-Eastern Jordan). *Levant* 48.3: 220-235.
Rowan, Y., Rollefson, G.O., Wasse, A., Abu-Azizeh, W., Hill, A.C., Kersel, M.M.
2015 The Land of Conjecture: New Late Prehistoric Discoveries at Maitland's Mesa and Wisad Pools, Jordan. *Journal of Field Archaeology* 40.2: 176-189.
Zarins, J.
1979 Rajajil: A unique Arabian Site from the Fourth Millennium BC. *Atlal* 3: 73-78.